National Integration and Institution Building

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Abstract

The mutual dependence between national integration and institution building is established in a formal model. It is shown that a decrease in transportation costs, but not necessarily an increase in population size, reduces the equilibrium number of states and the adoption of rule-based institutions. With endogenous transportation costs or endogenous population size, the unification process can feed on itself. The model is illustrated by the state of Qin's unification of China in 221 BC. During this process of national integration, transformations from relation-based governance to rule-based governance happened.

Keywords: National integration, institution building, China, rule-based governance, optimal size of nations

JEL Classification Numbers: N45, H56, R40

1. Introduction

National integration interacts with institutional building. On the one hand, national integration induces institutional building. This can be seen from the state of Qin's unification of China for the first time in 221 BC, a significant event in China's history. Some important changes happened during the Warring States period (475 BC – 221 BC) prior to Qin's unification of China. While population sizes were increasing before the invention of iron, the usage of iron increased productivity and increased population size further. With higher population sizes, the demand for land increased and states engaged in wars of annexation (Yang, 1998, chap. 6). Government organizational changes and cultural integration happened during this process. First, when states engaged in wars of annexation, survived states became larger and a fundamental organizational change was the spread of counties in various states (Zhou, 2018). Second, surviving states adopted Legalist institutions, replacing Confucian institutions at the beginning of the Western Zhou dynasty. [1] Confucianism originated with management of small states. Compared with Confucianism, Legalism emphasizes the building of rule-based institutions in national governance. Overall, during this national integration process, there was a transition from relation-based governance to rule-based governance when population size increased and transportation improved.

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[1] While Confucius (551-479 BC) lived during the years near the end of the Spring Autumn period, institutions consistent with Confucianism such as feudalism (分封制) could be traced back earlier to the beginning of the Zhou dynasty, as established by the King Wu of Zhou (?-1043 BC) (Yang, 1999, p. 120).

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On the other hand, institutional building can increase the degree of national integration. A common language and institutions such as the commandary-county system (郡县制) and the imperial examination system helped to maintain China's unity.

The interaction between the adoption of rule-based institutions and national integration could also be relevant to other countries, such as the formation of nation states in Europe. Military technologies changed the conduct of war, and the growth of military technologies played a significant role in driving state formation in Europe (Parker, 1996). City-states were small-scaled and had fragmented sovereignty if compared with national states. When successful warfare began to depend on mass armies recruited from a state's own population, city-state and city-empire lost out (Tilly, 1992). For the national integration process in France, France promoted the unification of measurement units. During the French Revolution, privileges of nobility such as exemption from taxes were eliminated. The Code Napoleon gave equality before the law to everyone. For the national integration process in German, German promoted a common language. Prussia pushed the formation of the Zollverein, or German Customs Union. In the nineteenth century, railways were built, which interacted with the German unification process: national integration increased market size and made railway building profitable, while railways increased the degree of national integration (Keller and Shiue, 2020).

In this paper, we address the mutual dependence between national integration and institutional building and study how the interaction between national integration and the adoption of rule-based institutions is affected by some key parameters such as population size and the level of transportation costs in a formal model. This paper contributes to the literature by emphasizing the process of national integration in ancient China as a process of transformation from relation-based governance to rule-based governance. In this model, states compete in serving citizens by providing public services. Rulers choose institutions with different levels of fixed and marginal costs. Like Zhou (2004, 2009, 2014, 2022), a more rule-based institution is assumed to have a higher fixed cost but a lower marginal cost in providing public services to citizens. This assumption can be motivated by the observation that the county system and Legalist institutions are more rule-based than feudalism and Confucian institutions (Qu, 2010)[2] and could have higher fixed costs to

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[2] As illustrated in Qu (2010, Chap. 6), Confucianism emphasizes rites (礼) which are relation based: rites should be different for individuals with different social status and family status. Legalism argues that law should be equally applied to everyone, regardless of status.

set up. One example is the Reforms of Shang Yang which standardized language and measures (Li, 1977). During this process of standardization, fixed costs of providing services to citizens increased, while marginal cost decreased.[3] While rule-based governance has higher fixed costs, marginal costs could be much lower than relation-based governance (Li, 2003). When population size increased, the adoption of rule-based institutions became rational. The adoption of rule-based institutions such as the county system helped to handle higher volumes of government activities when newly occupied land was integrated into the state of Qin.

First, we establish the mutual dependence between national integration and institutional building. Second, consistent with historical evidence, we show that an increase in population size may not necessarily lead to the unification of a country because the equilibrium number of states may not decrease. However, a decrease in the level of transportation costs always helps the unification of a country because a reduction in the level of transportation cost always reduces the equilibrium number of states. If the equilibrium number of states decreases to one, the country becomes unified. Finally, the process of national integration and the adoption of rule-based institutions can feed on itself. When countries adopt more rule-based institutions, they have lower costs and thus become more competitive in providing public services. This will attract more citizens from other states and could lead to another round of institutional formalization. With more rule-based governance, transportation costs (which may also be interpreted as population heterogeneity) will decrease. This could induce the adoption of another round of rule-based institutions. Eventually, the country could become integrated into one state, as happened in China when the state of Qin unified the country in 221 BC.

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[3] This process of the adoption of rule-based institutions is like technology adoption in the transportation sector in the 20th century. Levinson (2006) provides an interesting study of the history of the adoption of containers. Before the introduction of containers in the 1950s, the loading and unloading of cargos were handled by longshoremen and marginal costs were high. Compared with loading and unloading by longshoremen, containerization is a technology with higher fixed costs but lower marginal cost of production. With containerization, marginal costs of loading and unloading decrease. The usage of containers led to sharp rises in the fixed costs because ports need to build special terminals to handle containers and transportation companies need to purchase dedicated containerships. The cost of building a container port is ten times of that of a traditional port, but a container port can handle twenty times of goods handled by a traditional port. If the volume of transportation is high, it pays to containerize because the fixed costs of containerization can be spread over a high level of output and the average cost of production will be lower. The adoption of containers led to sharp decreases in transportation costs and international trade increased dramatically. In terms of the tradeoff between fixed and marginal costs of production, the process of containerization is like the adoption of rule-based institutions such as the commandery-county system (referred to as county system later in this paper for simplicity).

This paper is related to several lines of literature. First, since Legalism is more rule-based than Confucianism, this paper is related to the literature on relation-based governance versus rule-based governance. In a stimulating paper, Li (2003) describes the difference between rule-based governance and relation-based governance. Under relation-based governance, Li argues that individuals will first interact with family members, then friends, then individuals from the same provinces or/and same universities to reduce transaction costs. However, the potential of increasing transactions is limited because the marginal cost increases sharply during this process. Consistent with our model, Li thinks that relation-based system has a low fixed cost and a high marginal cost of production, compared to a rule-based system. Li argues that a transition from relation-based to rule-based system is necessary when the amount of transaction increases. While Li is descriptive, Dixit (2003) provides a formal model on relation-based versus rule-based governance. In Dixit, individuals are located around a circle. When population size increases, the gains from relation-based trade may decline and a switch to a rule-based trade happens. One significant difference between this paper and Dixit (2003) is that the choice of institutions is not addressed in his model. Huang (2013) addresses why societies differ in their relative usage of relational and legal contracts, and the key tradeoff is that a relational contract has gains from learning while an outside trading opportunity may lead to a larger gain. She offers a political economy consideration in the choice of contract enforcement when elite and the mass differ in their interests in developing legal institutions. This paper complements Huang's model by studying the choice of contract enforcement from a different perspective: the tradeoff between fixed and marginal costs of production. This paper extends the literature on relation-based governance by treating the degree of formality of institutions as a continuous choice variable rather than a discrete one. With a continuous choice variable, tools in calculus can be applied to address how exogenous parameters affect the degree of formality of institutions.

Second, this paper is related to the literature on the relationship between the size and number of nations and performance, such as Alesina and Spolaore (2003). One key tradeoff in this line of literature is as follows: A larger nation helps to achieve increasing returns in production, but preference heterogeneity will be less likely to be satisfied. In Alesina and Spolaore (2005), individuals and countries are located around a circle. Since a country can occupy nearby land, countries allocate resources to prepare for wars and the outcome of a war is affected by the amount of resources allocated in preparing for the war. The main result is that if international conflict is

less likely, a higher number of countries will emerge in equilibrium. In Kitamura and Lagerlof (2020), state borders are affected by mountains, rivers, and amounts of rain. They show that while competition among states benefits long-run development, center states benefit more than periphery states. Adamson (2021) study the relationship between the size of countries and conflicts in Africa. This paper contributes to the literature on the size of nations by incorporating the choice of the degree of formality of institutions into the study of the size and number of nations.

The plan of the paper is as follows. Section 2 specifies the model and derives results when the number of states is exogenously given and when the number of states is endogenously determined. Section 3 addresses the socially optimal number of states and the degree of formality of institutions. Section 4 extends the model by considering endogenous transportation costs and endogenous population size, which is used to explain that the unification process can feed on itself. Section 5 illustrates historical evidence on national integration and the adoption of rule-based institutions in the Spring and Autumn and the Warring States periods to illustrate the model. Section 6 discusses some potential generalizations and extensions of the model and concludes.

2. The model

Nations are located along a circle (Salop, 1979; Alesina and Spolaore, 2003; Dixit, 2003). The circumference of the circle is normalized to one. Citizens are located uniformly around the same circle. The size of the population on the circle is L, which is exogenously given. All travels occur along the circle. Nations provide a good (which can be interpreted as public service) to citizens. A citizen needs to incur transport costs to buy this product if there is no nation locating at the same point of this citizen. The unit transport cost is t, a positive number. The level of transport costs could also be interpreted a measure of population heterogeneity: the higher this parameter, the higher the degree of population heterogeneity.

Each citizen has a valuation V of the public service, and V is an exogenously given positive number. For a citizen to consume public service, he needs to pay the price and incurs the transportation costs. Thus, the generalized cost is the price paid to a nation plus transport costs. A citizen will purchase a unit of a public service if the generalized cost is not higher than this citizen's valuation of the public service. If the generalized cost is higher than this citizen's valuation, this citizen does not purchase.

States may choose the degree of formalization of their institutions which determine their fixed and marginal costs of providing the public service. States also choose their outputs to maximize surpluses. We focus on a symmetric equilibrium in which all states charge the same price in providing public service and choose the same degree of formality of institutions in equilibrium.

First, to address how national integration affects institutional building, we study a state's institutional choice while the number of states is exogenously given. Second, to study how institutional building influences national integration, we examine the number of states when institutions are exogenously determined. Third, we address the joint determination of the number of states and institutional choice.

2.1 Exogenous number of states

In this subsection, the number of nations is exogenously given. Similar to Zhou (2004, 2009, 2014, 2022), to provide public service, it is assumed that there is a continuum of institutions indexed by a number $n \in R_+^1$. A higher value of n refers to a more rule-based institution. The fixed cost of providing public service associated with institution n is $F(n)$ and the corresponding marginal cost is $\beta(n)$. The cost functions are assumed to be twice continuously differentiable. When a nation chooses its institution, it faces the following tradeoff: a more rule-based institution has a higher fixed cost but a lower marginal cost in providing public service. That is, $F'(n) > 0$ and $\beta'(n) < 0$. For the second order condition to be satisfied, we also assume that the fixed costs increase at a nondecreasing rate and marginal cost decreases at a nonincreasing rate: $F''(n) \geq 0$ and $\beta''(n) \geq 0$.[4] The modeling of the degree of formality of institutions here is consistent with Li (2003) who argues that rule-based governance has higher fixed costs of production.

Let m denote the number of states and $m \in R_+^1$. The price a state charges an individual for its service is p_i. Let the price charged by other states be p_{-i}. As shown in Figure 1, states are assumed to locate equal distance from each other.[5]

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[4] This assumption on second order condition can be motivated by the following example. Suppose a firm's current marginal cost is c, a positive number. This firm can conduct research and development (R&D) to reduce its cost. If this firm wants to reduce its marginal cost by e, the corresponding R&D cost is $e^2/2$, a convex cost function. In this case, R&D cost can be viewed as fixed cost, and realized marginal cost is $c - e$. With $f'' > 0$ and $\beta'' = 0$, this fixed cost and realized marginal cost satisfy the second order condition in this model.

[5] Like Salop (1979), this abstraction from location choice of nations allows us to focus on the choice of institutions, which is the essential question to be addressed in this model.

When population size is small, some citizens may not be provided with public service, as under feudalism when individuals live in countryside far away from political centers (Hui, 2005). To make things more interesting, suppose population size is large enough and all citizens are served. In this case, a state has two competitors which are the two states located on the two sides of this state. For a citizen with a distance of x from state i, the distance between this citizen and state i's closest competitor is $\frac{1}{m} - x$. If this citizen gets service from state i, the generalized cost is $p_i + tx$. If this citizen purchases from state i's closest competitor, the generalized cost is $p_{-i} + t\left(\frac{1}{m} - x\right)$, as shown in Figure 2.

[Insert Figure 2 here.]

A citizen is indifferent between purchasing service from the two states if the generalized costs of the two states are the same:

$$p_i + tx = p_{-i} + t\left(\frac{1}{m} - x\right). \tag{1}$$

From the above equation, the price charged by state i can be expressed as $p_i = p_{-i} + t\left(\frac{1}{m} - 2x\right)$. A state serves citizens on both sides of its location and this its output is $2xL$. The level of surplus for the ruler of this nation can be expressed as

$$2xL\left(p_{-i} + t\left(\frac{1}{m} - 2x\right) - \beta(n)\right) - F(n). \tag{2}$$

The ruler of a state chooses output x to maximize the level of surplus. The first order condition with respect to output is

$$x = (p_{-i} - \beta + \frac{t}{m})/4t. \tag{3}$$

Equation (3) shows that a nation's output decreases with the number of competing states and the level of transportation cost (or the degree of population heterogeneity).

Plugging (3) into $p_i = p_{-i} + t\left(\frac{1}{m} - 2x\right)$, the price charged by a state for its service is

$$p_i = \frac{p_{-i} + \beta}{2} + \frac{t}{2m}. \tag{4}$$

Plugging (3) into (2), the level of surplus of a state can be expressed as

$$\pi_i = \frac{\left(p_{-i} - \beta(n) + \frac{t}{m}\right)^2 L}{4t} - F(n). \tag{5}$$

In addition to output choice, state i chooses the degree of formality of its institution n optimally to maximize its surplus. The first order condition with respect to institution choice is

$$-\frac{\left(p_{-i} - \beta + \frac{t}{m}\right)}{2t} \beta' L - F' = 0. \tag{6}$$

The second order condition requires that

$$-\frac{\left(p_{-i} - \beta + \frac{t}{m}\right)\beta'' L - \beta'\beta' L}{2t} - F'' < 0.$$

In a symmetric equilibrium, all states charge the same price for public service. Let this price be p. From equation (4), the price charged by a state for its service is given by

$$p_i = p_{-i} = p = \beta + \frac{t}{m}. \tag{7}$$

From equations (6) and (7), a state's institution choice is determined by

$$-\frac{L}{m}\beta'(n) - F'(n) = 0. \tag{8}$$

The following proposition addresses how institutional choice is affected by population size and the number of states.

Proposition 1: When the number of states is exogenously given, (i) the degree of formality of a state's institution increases with population size; (ii) the degree of formality of institutions decreases with the number of competing states.

Proof: Applying implicit function theorem on (8) yields $\frac{dn}{dL} > 0$ and $\frac{dn}{dm} < 0$. ∎

Proposition 1 is easy to understand. An increase in population or a decrease in the number of competing states increases market size for a nation. This helps the adoption of more formal institutions because the higher fixed costs can be spread over a higher level of output and average cost of providing public service becomes lower.

2.2 Exogenous degree of formality of institutions

The number of states during the Spring Autumn and Warring States period changed over time. On the one hand, the number of states could decrease when some states were annexed by

other states. On the other hand, the number of states could increase when new states were created, such as the state of Zheng (郑) which came into existence in 806 BC (much later than states such as Qi). Also, a state could be divided into several states, as happened in the state of Jin (晋) which was divided into three states (Sima, 1988). To address the process of national integration in which the number of states changes over time, the number of states is determined endogenously in this subsection. Any individual who is willing to incur the fixed costs of establishing institutions may found a state, like what happened in ancient China when a dynasty was overthrown. One example is that various groups revolted against the Sui government when Yang Guang (杨广) was the emperor. For simplicity, here the number of states is a real number rather than restricted to be an integer. With entry and exit of states, a state earns a surplus of zero. From equation (5), the zero-surplus condition for a state is

$$\frac{\left(p - \beta + \frac{t}{m}\right)^2 L}{4t} - F = 0. \tag{9}$$

Plugging equation (7) into equation (9), the equilibrium number of states is determined by

$$\Gamma_1 \equiv \sqrt{\frac{tL}{F(n)}} - m = 0. \tag{10a}$$

The following proposition addresses how the degree of national integration depends on the degree of formality of institutions.

Proposition 2: A higher degree of formality of institutions induces a higher degree of national integration.

Proof: When the degree of formality of institutions is exogenously given, applying implicit function theorem on (10a) yields $\frac{dm}{dn} < 0$. ∎

Part ii of Proposition 1 shows how institutional choice depends on national integration while Proposition 2 shows how national integration depends on institutional choice. Thus, those two propositions establish the mutual dependence between national integration and institutional building.

2.3. Endogenous number of states and endogenous degree of formality of institutions

Plugging equation (10a) into equation (6), the optimal degree of formality of institutions when the number of states is endogenously determined is defined by

$$\Gamma_2 \equiv -\beta'(n)\sqrt{F(n)} - F'(n)\sqrt{\frac{t}{L}} = 0. \tag{10b}$$

Equations (10a) and (10b) form a system of two equations defining the equilibrium number of states and the degree of formality of institutions as functions of exogenous parameters. Partial differentiation of equations (10a) and (10b) yields

$$\begin{pmatrix} \frac{\partial \Gamma_1}{\partial m} & \frac{\partial \Gamma_1}{\partial n} \\ 0 & \frac{\partial \Gamma_2}{\partial n} \end{pmatrix} \begin{pmatrix} dm \\ dn \end{pmatrix} = - \begin{pmatrix} \frac{\partial \Gamma_1}{\partial L} \\ \frac{\partial \Gamma_2}{\partial L} \end{pmatrix} dL - \begin{pmatrix} \frac{\partial \Gamma_1}{\partial t} \\ \frac{\partial \Gamma_2}{\partial t} \end{pmatrix} dt. \tag{11}$$

From (10b), with the second order condition for a nation's optimal choice of institutions in mind, it is clear that $\frac{\partial \Gamma_2}{\partial n} < 0$. With $\frac{\partial \Gamma_1}{\partial m} < 0$, the determinant of the coefficient matrix of endogenous variables of (11) is positive:

$$\Delta \equiv \frac{\partial \Gamma_1}{\partial m} \frac{\partial \Gamma_2}{\partial n} > 0.$$

With Δ nonsingular, there exists a unique equilibrium for system (11).

Population growth is frequently cited as a reason for states engaging in wars in the Warring States period (Hui, 2005; Zhao, 2015). The following proposition studies the impact of a change in population size.

Proposition 3: When the number of states is endogenously determined, if population size increases, a state will adopt more formal institutions. The impact of a population change on the equilibrium number of states is ambiguous.

Proof: Applying Cramer's rule on (11) yields

$$\frac{dn}{dL} = -\frac{\partial \Gamma_1}{\partial m} \frac{\partial \Gamma_2}{\partial L} / \Delta > 0,$$

$$\frac{dm}{dL} = \left(\frac{\partial \Gamma_1}{\partial n} \frac{\partial \Gamma_2}{\partial L} - \frac{\partial \Gamma_1}{\partial L} \frac{\partial \Gamma_2}{\partial n} \right) / \Delta.$$

Since the sign of $\frac{\partial \Gamma_1}{\partial n} \frac{\partial \Gamma_2}{\partial L} - \frac{\partial \Gamma_1}{\partial L} \frac{\partial \Gamma_2}{\partial n}$ is ambiguous, the sign of $\frac{dm}{dL}$ is ambiguous. ∎

The intuition behind Proposition 3 is as follows. A higher population increases market size, and this makes the adoption of a more formal institutions profitable because the higher fixed costs can be spread over a higher level of output. When population increases, there are two effects on

the equilibrium number of states. First, the direct effect through L is that a higher population allows a higher equilibrium number of states. Second, the indirect effect is that each state chooses a more formal institution. To recover higher fixed costs from a more formal institution, a state needs to serve a higher number of citizens. The latter effect tends to reduce the number of states. The two effects work in opposite directions. Overall, the impact of a population increase on the equilibrium number of states is ambiguous.

Proposition 3 is consistent with historical evidence. While population usually declined during wars and population increased during peace, roughly speaking China's population increased over time (Zhou, 2009). While sometimes China was unified; some other times China was divided. There is no monotonic relationship between population size and the degree of unification of China (Ge, 2013).

The building of railways reduced transportation costs and helped national integration of various countries during the industrialization process. The following proposition studies the impact of transport costs on the equilibrium number of states and a nation's choice of institutions.

Proposition 4: When the number of states is endogenously determined, if the level of transportation costs increases, the equilibrium number of states will be higher, and each state will choose a less formal level of institution.

Proof: Applying Cramer's rule on (11) yields

$$\frac{dn}{dt} = -\frac{\partial \Gamma_1}{\partial m}\frac{\partial \Gamma_2}{\partial t}/\Delta < 0,$$

$$\frac{dm}{dt} = \left(\frac{\partial \Gamma_1}{\partial n}\frac{\partial \Gamma_2}{\partial t} - \frac{\partial \Gamma_1}{\partial t}\frac{\partial \Gamma_2}{\partial n}\right)/\Delta > 0. \blacksquare$$

The intuition behind Proposition 4 is as follows. When the level of transportation costs increases, a higher number of states can survive in equilibrium so that citizens can be served by nearby states to save transportation costs. When the number of states increases, each state is serving a smaller number of citizens because population size is fixed. A lower output makes it advantageous to adopt a less formal level of institution to save fixed costs of adopting institutions.

Proposition 4 can be used to interpret historical evidence. The reduction in the number of political units in the Spring and Autumn and the Warring States periods can be explained by reductions in transportation costs.[6]

When the equilibrium number of states is one, the country is unified. From Propositions 2 and 3, an increase in population size may not necessarily lead to the unification of the country because the equilibrium number of states may not decrease. However, a decrease in transportation costs helps the unification of the country because a reduction in transportation cost always reduces the equilibrium number of states.

3. The social optimum

In this section, we study the benchmark case by addressing the socially optimal level of institution and optimal number of states. This can be motivated by arguing that at the beginning of the Zhou dynasty the Zhou ruling house may choose the number of states and the level of formality of institutions. At that time, Zhou ruling house established some states in strategic locations (Hui, 2005; Zhou, 2018).

The social planner's objective is to maximize social welfare. Since an individual's valuation of public service and population size are given, maximization of social surplus is the same as minimization of the sum of production and transportation costs (Salop, 1979). That is, the social planner tries to minimize total cost, which is the sum of production costs and transport costs. If the social planner chooses m states, total production cost is $mF + \beta L$. For an individual at a location with a state located at the same site, the distance of transportation is 0 (the lowest distance of travel among all citizens); for an individual in the middle of two states, the distance of transportation is $\frac{1}{2m}$ (the highest distance of travel among all citizens). Integrating over individuals, total transport cost is $2mtL \int_0^{1/(2m)} x \, dx$. Thus, the social planner tries to minimize

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[6] Transportation costs are related to geographic conditions. Chinese culture originated in the North China Plain, this helped Qin's unification of China. Hicks (1969) has used difference in geographic conditions to explain the unification of China and lack of that in Europe. Hicks (1969, pp. 38-39) writes: "The fact that European civilization has passed through a city-state phase is the principal key to the divergence between the history of Europe and the history of Asia. The reason why it has done so is mainly geographical. The city state of Europe is a gift of the Mediterranean. In the technical conditions that have obtained through the greater part of recorded history, the Mediterranean has been outstanding as a highway of contact, between countries of widely different productive capacities; further, it is rich in pockets and crannies, islands, promontories, and valleys, which in the same conditions have been readily defensible. Asia has little to offer that is at all comparable."

$$mf + \beta L + 2mtL \int_0^{1/(2m)} x \, dx = mF + \beta L + \frac{tL}{4m}. \qquad (12)$$

The social planner chooses the number of states and the degree of formality of institution to minimize (12). The first order condition with respect to the number of nations is

$$F - \frac{tL}{4m^2} = 0. \qquad (13)$$

The first order condition with respect to the level of institution is

$$mF' + \beta'L = 0. \qquad (14)$$

Let the equilibrium variables associated with social optimum carry an asterisk mark. From equations (13) and (14), it can be shown that

$$m^* = \frac{1}{2}\sqrt{\frac{tL}{F(n^*)}}. \qquad (15a)$$

$$2\beta'(n^*)\sqrt{F(n^*)} + F'(n^*)\sqrt{\frac{t}{L}} = 0. \qquad (15b)$$

Equations (15a) and (15b) form a system of two equations defining the number of states and the degree of formality of institutions in a social optimum. The following proposition studies properties of the social optimum and compares the number of states and the degree of formality of institutions when the number of states is endogenously determined with those in the social optimum.

Proposition 5: (i) In a social optimum, when population size increases, the social planner will adopt more formal institutions, while the impact on the optimal number of states is ambiguous. If the level of transportation costs decreases, the social planner will choose a higher number of states, and each state will have a more formal level of institution. (ii) The number of states determined endogenously is higher than that in the social optimum. The level of formality of institution with endogenously determined number of states is lower than that in the social optimum.

Proof: By partially differentiating equations (15a) and (15b), the first part of the proposition can be proved by using the method used in proving Propositions 1 and 2.

For the second part, a comparison of equations (15b) with (10b) reveals that $n^* > n$ and a comparison of equations (15a) with (10a) reveals that $m^* < m$. ∎

Proposition 5 is consistent with Salop (1979) who shows that compared with social optimum a market economy produces too many varieties. To understand Proposition 4, when a

state enters, it has a business stealing effect on other nations. Since states ignore this externality in a free-entry equilibrium, that explains why the number of states is too high. With a higher number of nations in a free-entry equilibrium, the output for a nation in a free-entry equilibrium is lower because total population size is fixed. With a lower output, a state in a free-entry equilibrium chooses a lower level of formality of institution.

The number of political units established by the Zhou ruling house over time came to hundreds. This does not necessarily contradict Proposition 5 because the number of states under free entry at that time could be even higher. The number of political units declined in the Spring and Autumn and Warring States periods. The reason is that population size increased and transportation costs decreased significantly from the establishment of the Zhou dynasty and Qin's unification of China.

4. An extension: Endogenous transportation cost or endogenous population size

A state can reduce transportation costs by building transportation infrastructure. For example, Zhao (2015) illustrates the building of transportation infrastructure such as canals which lowered transportation costs.

The endogeneity of transportation costs can be modeled by specifying t as a function of n: $t(n)$. Under this modification, transportation costs decrease with the level of rule-based institutions: $t'(n) < 0$. For example, Qin Shihuang built roads connecting the country after his unification of China (Sima, 1988, p. 60). Alternatively, if t is interpreted as population heterogeneity, adoption of common language and behavioral standards can reduce population heterogeneity. Then, equation (10b) defining the level of institutional formality when the number of states is endogenously determined becomes

$$-\beta'(n)\sqrt{F(n)} - F'(n)\sqrt{\frac{t(n)}{L}} = 0. \tag{16}$$

For equation (16), with $t'(n) < 0$, the left-hand side of equation (16) may not be a monotonic function of n. Thus, it is possible for equation (16) to have multiple solutions. That is, multiple equilibria with different levels of transport costs and degrees of formality of institutions are possible.

This extension can be used to capture the unification process as a process feeding on itself. Suppose that the level of transport costs decreases. Since the equilibrium number of states is lower,

this leads to consolidation of states. The larger states then take measures to reduce transport costs. A lower transport costs initiates another round of national integration. During this process, smaller states will be kept on being integrated into larger ones. Eventually the country become unified, as happened in 221 BC when the state of Qin unified China.

Alternatively, the size of the population can be made endogenous by specifying population size as a function of the formality of institutions: $L(n)$. For example, during the Reforms of Shang Yang, there were policies encouraging population growth through taxing heavily adult sons living together with fathers and policies attracting immigrants from other states (Sima, 1988). Suppose that the adoption of more rule-based institutions causes population size to increase: $L'(n) > 0$. Then, equation (10b) defining the level of institution when the number of states is endogenously determined becomes

$$-\beta'(n)\sqrt{F(n)} - F'(n)\sqrt{\frac{t}{L(n)}} = 0. \tag{17}$$

Like equation (16), since the left-hand side of equation (17) may not be a monotonic function of n, multiple equilibria with different levels of population sizes and degrees of formality of institutions can exist for (17). Endogeneity of population size can also cause the adoption of rule-based institutions to feed on itself. As happened in the Reforms of Shang Yang, institutions encouraging population growth may be implemented. With a higher level of population, another round of adoption of more rule-based institutions could happen.

5. National integration and adoption of rule-based institutions in ancient China

In this section, we illustrate the interaction among technological development, the emergence of large-scale wars, national integration, and institution-building in the Spring and Autumn and the Warring States periods. Because vassals engaged in wars of annexation, the number of autonomous political powers decreased over time. At the beginning of the Spring and Autumn period (770 BC – 476 BC), there were hundreds of political units. Eventually the state of Qin unified China in 221 BC. Qin's unification made further national integration possible through standardization of language, measure, and moral standards across the country (Sima, 1988).

5.1. Technology, transportation, and wars

One aspect of technology development at that time was the usage of iron.[7] With the usage of iron, large-scale clearing of unused land became possible (Yang, 2004). With more land used, population sizes increased.[8] While population scattered at strategic locations at the beginning of the Spring and Autumn period, Han Fei (韩非), a famous scholar at that time, already worried about that population growth was too high at the end of the Warring States period.[9]

The usage of iron helped building roads and canals (Yang, 2004). For example, in the state of Wu, canals were built for military purposes. With canals such as Hangou (邗沟) connecting Huai River in Huaian and Yangtze River in Yangzhou built in 486 BC, transportation improved. Iron began to replace cooper to produce weapons. Weapons made from iron were sharper. During the period of Eastern Zhou (770 BC – 256 BC), states initially engaged in wars at local level, mainly with their neighboring states. Distance traveled by armies were limited and China could be roughly divided into four military zones at that time. Later, different military zones became integrated and wars became national (Zhao, 2015). Early wars followed rites and captured enemy soldiers could be released with food, and chariots played an important role. However, generals in late wars became more pragmatic and crueler. Infantry and cavalry played important roles and large number of enemy soldiers might be killed to reduce the military power of foreign states. Population size became essential in determining a nation's military power. Initially, only residents within towns (国人) had the right to serve in the army. Residents in towns and countryside (野人) became integrated when countryside men were recruited to join the army to increase the number of soldiers.

5.2. The spread of the county system

One aspect of the adoption of rule-based institutions was the spread of the county system. There were three types of government organizational forms in ancient China: feudalism under

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[7] Yang (2004) provides a detailed study of the usage of iron and steel in ancient China. The development of technologies to produce iron was related to cooper production earlier. Iron was first used in the south of China (such as in the state of Chu), produced by burning charcoal. Yang (2004, p. 141, pp. 313-316) illustrates the usage of iron in producing tools in agriculture.

[8] Population size data for Eastern Zhou are based on estimates, frequently from the number of soldiers of states. One estimate is that population size was about 4.5 million at the end of the Spring and Autumn period and about 20 million at the end of the Warring States period which was about 250 years later. However, this estimate of population size is challenged by Ge (2002, Chap. 6).

[9] When all land became occupied, land became scarce and the value of labor decreased, this helps to explain the killing of soldiers of enemy states. Previously, with abundant land, labor was scarce and valuable. This helps to explain why the Zhou ruling house deployed Shang population when Zhou overthrew Shang, rather than killing Shang people.

which kingdoms were dominant, the commandery-county system, and the mixed form under which both counties and kingdoms played significant roles (Zhou, 2012).[10]

To reward relatives and friends, the Zhou dynasty (1045 BC-256 BC) practiced feudalism. Within a state, secondary feudalism could happen in large states when land was awarded to Great Officers (Zhao, 2015). Because rulers of states and Great Officers had their independent military forces, while the Zhou ruling house could not control the states effectively, within a state powerful Great Officers frequently rebelled against the ruler. Over time the power of the Zhou ruling house declined (Sima, 1988).

Zhou (2005, chap. 1) illustrates the process of the evolution of counties and commanderies in the Spring and Autumn and the Warring States periods, especially in the states of Jin and Chu. The adoption of the county system interacted with higher degrees of increasing returns in military technologies (Yang, 1998, chap. 6). With the demand of a large number of infantry in mind, when a large state conquered a small one and acquired its territory, this piece of territory could be organized into a county ruled directly by the king. A ruler might also integrate pieces of territories already under his control to form counties (Yang, 1998; Zhou, 2005). Qin was the first state to establish counties throughout the state under the Reforms of Shang Yang (Lin, 1981). After China was unified, there was a debate between the prime minister Li Si (李斯) who supported the adoption of the county system and some government officials who supported feudalism. Qin Shihuang, China's first emperor, supported Li Si and the Qin dynasty (221 BC-207 BC) adopted the county system nationwide (Sima, 1988; Ma and Rubin, 2019).

5.3. Reforms and the adoption of rule-based institutions in general

Faced with serious external threats, states engaged in reforms to adopt more rule-based governance to increase their military capacities.[11] This kind of institutions are later called Legalist institutions even though individuals at that time did not use this term.

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[10] The county system was the dominant government organizational form in ancient China after the Qin dynasty.

[11] Marquis Wen (472 BC -396 BC) of the state of Wei, hired Li Kui (李悝) to conduct reforms in Wei. Li Kui eliminated prerogatives of nobles and used incentives to elicit desired behaviors. With the reforms, the state of Wei became the first superpower in the Warring States period. Also, Wu Qi (吴起) tried to reform in the state of Chu. From 386 BC to 381 BC, King Dao of Chu employed Wu Qi as a prime minister to reform. To concentrate scarce resources on military purposes, Wu Qi reduced the stipends of nobles and eliminated redundant government positions (Sima, 1988, pp. 523-525).

In 536 BC, Zichan (子产) in the state of Zheng published law publicly (Wu, 2004, p. 98), started the process of treating nobles and commons in the same way, an aspect of national integration. This is the first time in China's history with laws published publicly. Publishing law publicly is a kind of rule-based institutionalization which reduced the degree of arbitrary application of laws. As well-known in economics, with better protection of property rights, this kind of reform would improve economic performance. Some other states such as Jin later also published their laws. Another aspect of Zichan's reform was the reform of tax institutions. The government began to treat private and public owned land in the same way and taxed them.

Started at 356 BC, Shang Yang introduced two rounds of institutional reforms in the state of Qin in about twenty years. During this process, Shang Yang took measures so that the public understood the new laws. His reforms had the following elements. First, individuals exclaiming new pieces of land would be granted ownership of the land. Policies such as tax incentives were used to attract immigrants and to encourage internal population growth. Second, individuals would be awarded government positions according to their contribution to the nation. Third, counties were established to be ruled by the ruler directly. Shang Yang also unified measure (Sima, 1988). Institutional reforms introduced by Shang Yang helped to consolidate resources for the Qin rulers (Zhou, 2018, 2021). Even though some other states also engaged in reform, the Reforms of Shang Yang were more comprehensive than those in other states. Thus, the state of Qin became a formidable superpower among the states. About 135 years after the Reforms, Qin Shihuang unified China.

While early reforms such as the reform by Zichan in the State of Zheng were not highly Legalist, late reforms such as the Reforms of Shang Yang were highly Legalist. The adoption of counties was an aspect of the switch from Confucianism to Legalism.[12] Confucianism might be appropriate for governing small communities. There are some significant features of Confucianism. First, this school dislikes the usage of material incentives and opposes the usage of severe punishments to rule. Second, Confucianism believes that human nature is good, and the ruler

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[12] Zhou (2011) has studied the choice between Confucianism and Legalism as the strategy of national governance. The tradeoff is as follows. Under Confucianism, there is a free-rider issue in the provision of efforts. National officials may not be the most capable because they are chosen through personal relations. Under the Legalism, the ruler provides strong incentives to local officials which may lead to side effects because some activities are noncontractible. By exploiting the paternalistic relationship between the ruler and the ruled under Confucianism and the strength of institution-building under Legalism, the ruler can benefit from a combination of Confucianism approach and Legalism approach as the national strategy of governance.

should find people with high moral standards and place them at important positions. This school does not emphasize rule-based institutions in inducing desirable behavior. Third, Confucianism discourages the usage of military power in handling international relations.

The Legalism school argues that law should be applied equally among all individuals, regardless of the position of an individual. Han Fei (about 281 BC - 233 BC), who was a member of the royal family in the state of Han, synthesized ideas of Legalism. There are some significant features of the Legalism. First, Legalism emphasizes the usage of incentives to govern. Second, like modern economics, the Legalism school believes that human being is selfish. Legalism emphasized using rule-based institutions in inducing desired behavior. Third, Legalism encourages the building of a strong army. For rulers trying to survive fierce wars, the Legalism approach was more practicable than Confucianism (Zhou, 2011). The Reforms of Shang Yang in the state of Qin is an example of the application of Legalism thoughts.

There are pros and cons of the Legalism.[13] On the one hand, Legalism emphasizes institution building. Legalist institutions of the Qin dynasty heavily influenced the institutions of all following dynasties. On the other hand, the cold-blood promotion of the interests of the ruler might backfire because citizens might feel aloof under a ruler adopting Legalism as the national strategy of governance. The usage of strong incentives under Legalism could induce citizens to cheat to take advantage of the incentive system (Zhou, 2011).

5.4. Military, legal practice, government organization, and culture integration and institution building

What can be learned from China's unification process in the Spring and Autumn and Warring States periods? This process was both a process of adopting rule-based governance and a process of national integration in military, legal practice, government organization, and culture. First, in terms of integration in the military sector, regardless of individuals living within towns or countryside, they became to be recruited into the army. See Chen (1991) for the transformation from relation-based governance to rule-based governance in the military sector. Second, in terms

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[13] The fast collapse of the Qin Dynasty led to harsh criticism of Legalism. In the Han dynasty, Emperor Liu Che (刘彻) adopted Dong Zhongshu's suggestions to promote Confucianism as the national philosophy of China to achieve cultural unity. While Confucianism received a high status as the national philosophy, in practice, institutions were frequently designed under the principles of Legalism. This kind of combination of Confucianism and Legalism was sometimes called a Confucianism exterior covering the Legalism core (Zhou, 2011; Zhao, 2015).

of integration of legal practice, Legalism emphasizes equal treatment of citizens. Third, in terms of integration of government organization, centralized bureaucracy was established to prepare for large scale wars. The county system has a more formal structure than that of feudalism. Finally, in terms of cultural integration, Confucianism is relatively relation-based in the sense that individuals are treated differently according to how close individuals are related, while Legalism is relatively rule-based in the sense that individuals living in the cities and countryside and nobles and commons are treated equally.

Legalism emphasizes the establishment of rule-based institutions. One example is Guan Zhong (管仲) who established various institutions such as those in organizing the government and the military in the state of Qi (Sima, 1988). Excavated bamboo records in places such as Hunan province show that laws in the state of Qin were quite comprehensive and formal. We have captured those aspects in the model by associating the process of national integration with the process of adoption of rule-based governance with higher fixed costs but lower marginal cost of production.

6. Conclusion

In this paper, we have demonstrated the mutual dependence between national integration and the adoption of rule-based institutions and have examined how this dependence is affected by some key factors such as population size and the level of transportation costs in a formal model. We have established the following analytical results. First, when population size increases, rulers will adopt more rule-based institutions, while the impact on the equilibrium number of states is ambiguous. Second, if the level of transportation costs decreases, the equilibrium number of states will be higher, and each state will choose a less formal level of institution. Third, the number of states endogenously determined is higher than that chosen by a social planner. Finally, if transport costs or population size is treated as endogenous, the process of adopting rule-based institutions can feed on itself. While the model is illustrated by historical evidence in the Spring and Autumn and the Warring States periods in China, this adoption of rule-based governance in the process of national integration is also relevant to the formation of nation states in Europe.

The model is simple, and it can be generalized and extended in various directions. First, to address how the number of countries is affected by the possibility of engaging in international transactions, one generalization is to incorporate the existence of international trade. Second, to

address difference in adopting institutions such as the county system, heterogeneity among states can be incorporated into the model.

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Figure 1: Location of nations
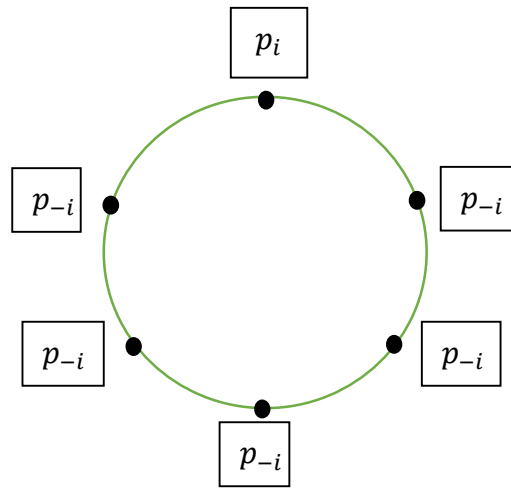
p_i

p_{-i} p_{-i}

p_{-i} p_{-i}

p_{-i}

Figure 2: Competition among nations

$\dfrac{1}{m} - x$ x   x $\dfrac{1}{m} - x$

p_{-i} p_i p_{-i}